ACCUMULATION OF ^{60}CO, ^{90}SR, ^{137}CS, ^{238}U AND TRANSURANIC ELEMENTS BY BERRY SHRUBS IN FOREST ECOSYSTEMS OF THE YENISEI RIVER BASIN

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Among terrestrial ecosystems contaminated with artificial radionuclides is the portion of the Yenisei River basin affected by the operation of the Mining-and-Chemical Combine (MCC), produced weapons-grade plutonium. There are very few data on radionuclide accumulation in forest ecosystems of these areas, and they mainly concern contamination of trees, as the main object of forest management. Other components of forest ecosystems, such as shrubs, which are also involved in accumulation and redistribution of radionuclides, have not been investigated until now. The purpose of this study is to estimate the transfer of artificial radionuclides, including transuranic ones, into berry shrubs via roots.
The berry shrubs *Ribes hispidulum*, *Ribes nigrum*, *Rosa majalis*, *Rubus idaeus*, and *Viburnum opulus* growing within the MCC 30-km zone were examined to determine accumulation of radionuclides from the soil. The contamination of the soils in the study area is not uniform owing to the complex topography of the area and the various routes of radionuclide entry. To date, the following radionuclides are recorded in the floodplain soils downstream of the MCC: ^{60}Co, ^{137}Cs, ^{152,154}Eu, ^{90}Sr, uranium, and isotopes of transuranic elements: ^{238}Pu, ^{239,240}Pu, ^{241}Am, ^{243,244}Cm. Investigations of radionuclide accumulation in the aboveground phytomass of berry shrubs were conducted during 2004-2010. All species were found to contain ^{137}Cs. The highest ^{137}Cs concentrations (up to 60 Bq/kg dry mass) were recorded in the samples collected in the downstream vicinity of the MCC. The only reliably detected radionuclide in the plants collected from control plots was ^{137}Cs. The shrubs *Rubus idaeus* and *Ribes nigrum*, which accumulated the greatest amounts of ^{137}Cs, were used in a detailed study of radionuclide accumulation, employing radiochemical analysis. The aboveground parts of *Rubus idaeus* and *Ribes nigrum* accumulated a wide range of radionuclides: ^{60}Co, ^{90}Sr, ^{137}Cs, ^{238}U, and transuranic elements ^{239,240}Pu, ^{241}Am, ^{243,244}Cm. Activity concentrations of transuranic elements ranged within 0.02-0.9 Bq/kg, and uranium concentration amounted to 0.012-0.14 mg/kg. Comparison of activity concentrations of different radionuclides in the organs of the shrubs showed different distribution patterns. The activities of ^{60}Co and ^{137}Cs grow as follows: “branches<leaves~berries”; the pattern for ^{90}Sr is “berries<branches<leaves”; the pattern for ^{239,240}Pu and ^{243,244}Cm is “branches<berries<leaves”. Similar differences were determined for the transfer factors (TFs) of the radionuclides. The range of TFs of transuranic radionuclides was comparable with that of ^{60}Co and ^{137}Cs (0.007-0.05).
Thus, the non-uniform distribution of radionuclides in the soil and the comparable TF values for ^{137}Cs and transuranic radionuclides suggest a conclusion that plants growing at certain sites can be expected to contain higher activity concentrations of transuranic elements. Also, the behavior of transuranic elements in ecosystems is not sufficiently understood so far. Therefore, the problems in their determination should not impede the progress of the studies on the distribution of these elements in ecosystems.